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The San José Scale-Insect: Its Appearance and Spread in Connecticut.

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THE SAN JOSÉ SCALE-INSECT; ITS APPEARANCE AND SPREAD IN CONNECTICUT.

By W. E. Britton, *State Entomologist.*

No other insect has caused so much destruction in fruit orchards throughout the country as the San José Scale (*Aspidiotus perniciosus* Comst.). This scale was first noticed by fruit shippers near San José, Cal., and was described by Prof. J. H. Comstock, in 1880. It was at that time doing much damage in California, and Prof. Comstock regarded it as the most destructive scale-insect which he had seen.

For several years the original habitat of this insect was undetermined, but recent observations point toward China as the probable country of its origin.*

Introduction into the Eastern States.

Though it caused much damage to fruit trees in California for several years, the scale was not known to exist in the Eastern States, until discovered in August, 1893, at Charlottesburg, Va. In March, 1894, an infested locality was found at Riverside, Md. In both cases, the introduction of the insect was traced to New Jersey nurseries, which had received the scale on nursery stock from California. Another infested area was discovered in March, 1894, at De Funiak Springs, Fla. Shortly afterwards Indiana, Pennsylvania, New Jersey, New York, Georgia, Ohio, Delaware and, in the summer of 1895, Alabama, Louisiana, Connecticut and Massachusetts were added to the list of infested states. At the present time, the San José Scale exists in nearly every portion of the United States, the extreme Northern states alone, perhaps, being exempt.

*At a meeting of the Biological Society of Washington, D. C., held Nov. 16th, Dr. L. O. Howard stated "that he had received a letter from Mr. C. L. Marlatt, announcing the discovery of the long-sought original habitat of the San José scale-insect; this was found to be in China, in the region to the South of the Great Wall. The scale-insect was preyed upon by a species of ladybird beetle, living examples of which were now on their way to the United States."—Science, Vol. XIV, No. 362, p. 895, Dec. 6, 1901.

Discovery and Distribution in Connecticut.

Ten years ago the San José or pernicious scale-insect was introduced into Connecticut on nursery stock from New Jersey. It escaped notice, however, until June 12th, 1895, when it was discovered at New London by Dr. W. C. Sturgis, Botanist of this Station. The insect had then been multiplying for four years in the orchard and garden of Mr. J. L. Raub, and several trees had been killed by it. A study of the locality was made and a bulletin was issued, calling attention to the presence of the insect in Connecticut, describing its appearance and injuries, and giving the best remedies known at that time. (See Bulletin No. 121, July, 1895.)

Soon after, specimens were received from Hartford and Bridgeport. During 1896, additional centers of infection were found at Darien, New Haven, Groton, Mystic, Farmington, New Britain, Plantsville, and in the following year, Meriden, Wallingford, Hamden, Woodbridge and Greenwich were added to the list. The scale was found in Ivoryton, Nichols, Cheshire, Burnside and Rowayton during 1898, and in several new localities in New Haven, Hartford and Bridgeport. Previous to July 1st, 1901, when the Insect Pest Law became operative, the San José scale had been found in seventy-eight localities in this State. The names of the towns and the number of infested localities in each town are as follows:

Ansonia—1, Berlin—1, Branford—1, Bridgeport—6, Burnside—1, Cheshire—1, Cromwell—2, Darien—2, East Haven—1, Fairfield—1, Farmington—1, Greenwich—2, Groton—2, Hamden—1, Hartford—8, Ivoryton—1, Lebanon—1, Lyme—1, Meriden—3, Milford—3, New Britain—1, New Canaan—1, New Haven—12, New London—3, Nichols—1, Norwich—1, Old Mystic—2, Plantsville—1, Rowayton—1, Saybrook—1, South Glastonbury—1, Shelton—1, South Norwalk—3, Southport—1, Stamford—1, Stratford—2, Terryville—1, Wallingford—1, Waterbury—1, Woodbridge—2.

In a few of the places noted, the insect was discovered before it had infested more than one or two trees. The immediate destruction of these infested trees has probably wiped out the pest from a very few localities, but in most cases the scale had spread to a serious degree before it was discovered, and many trees have been killed and a still greater number badly injured by its attacks.

Nursery Inspection in Connecticut.

Inasmuch as this insect has been distributed chiefly by means of nursery stock, several states previous to 1896 passed laws requiring that all nursery stock shipped into these states should be accompanied by a certificate of inspection issued by some authorized inspector. In the absence of any provision for the inspection of nursery stock in this State, Connecticut nurserymen were debarred from shipping stock into the states above referred to. During the season of 1897, the Station was first requested by Connecticut nurserymen to examine their stock and grant certificates, if not found to be infested. The Station complied as well as it could with the means at its command, and as requests for inspection grew more numerous, early in 1899 the Board of Control formally adopted regulations regarding such inspection and the granting of certificates. A circular embodying these regulations was printed and mailed to about seventy nurserymen, seedsmen and dealers in plants. In May, 1899, a bulletin on Inspection and Care of Nursery Stock, containing the Inspection Rules, was published and distributed. Up to the time the present law went into effect, about fifty inspections had been made and thirty-nine certificates granted. While this arrangement enabled the Connecticut nurserymen to ship into other states, it did not protect the buyers of nursery stock living within the State. If a nursery was badly infested, so that a certificate could not be granted, the owner could sell his plants and trees in Connecticut, where a certificate was not required. There was also nothing to prevent the shipping of infested stock into this State from those states which had no nursery inspection laws.

Legislation.

The fruit growers of Connecticut, represented by the State Pomological Society, urged the passage of a law regarding insect pests, chiefly because of the damage caused by the spread of the San José scale. The question was discussed at the annual meeting of the society in February, 1901, at Hartford, and the present law is the outcome of this agitation. This law was published in July, in Bulletin No. 134, of this Station. The law provides for the study of other pests as well as the San José scale. At the time the Connecticut law was enacted, at least twenty-five other states had passed similar measures.

Life History of the San José Scale.

Both the males and females pass the winter in an immature state, and do not reproduce until the latter part of June in this latitude. The present year, young were first observed on June 27th. The female does not lay eggs, but brings forth living young. The newly-born scales of both sexes crawl about for a few hours upon the twigs. They are provided with legs, eyes, antennae and mouth-parts. After they have found a suitable place, they settle upon the bark, insert their beaks and begin to suck the juice from it. Legs and antennae now disappear in both sexes, and the females lose their eyes. At first there is a white waxy substance exuded, which has somewhat the appearance of wool. A little later this seems to melt down and the insect casts its skin. The skin, together with the waxy substance, forms the beginning of the shell or covering. After feeding for about four weeks, the insect reaches the full-grown stage. If a female, it then begins to bring forth its young, continuing for a period of about six weeks. The number of young produced by a single female varies from less than one hundred in the early part of the season to nearly six hundred in late summer. The male feeds until full-grown, passes through the pupa stage, and finally the adult comes forth from under the shell, provided with eyes, wings, legs, antennae and organs of reproduction, but with no mouth-parts nor digestive system. He can, therefore, eat nothing after reaching the adult stage. His only mission is to mate with the female and die. The female, on the other hand, after becoming established upon the twig, loses legs, antennae, and eyes never again to be possessed of these organs, while its mouth-parts, digestive system and reproductive organs become very strongly developed. It cannot therefore move about, but feeds upon the juices of the plant and reproduces its kind. There are three complete generations each season in this latitude, and probably four in favorable seasons.

General Appearance of the Insect.

Usually the insect appears upon the bark as a greyish, rough coating, scarcely noticeable to the naked eye. At first there are but few individuals, generally found clustered around the

buds and at the branching of the twigs. Plate III, a, shows how the scales collect in a groove or hollow in one side of a twig, as if they had sought a sheltered situation. As the trees become more thoroughly infested, the bark may be completely covered, and sometimes there are several layers of scales covering the bark. In such cases leaves and fruit are usually attacked. The young scales locate upon both sides of the leaf, along the ribs (see Plate V, b), where they cause a reddish discoloration. This discoloration also occurs on fruits, and on the twigs, especially where there are but few individuals, and it is apparent not only on the outside, but extends through the bark to the wood. Where the insect is found upon the fruit, it seems to prefer the calyx and the stem cavities. Upon slightly infested trees the fruit is not attacked, but on trees which are badly infested the fruit is often so thoroughly covered as to present a very disgusting appearance. (See Plates IV and V.) If we examine the insect through a pocket lens, magnifying perhaps ten diameters, we see that it is distinctly circular in outline, somewhat raised above the bark, especially in the center where there is a small nipple, differing in color from the other portion. If infested twigs are much handled, the outer layer is rubbed away from the nipple, leaving it a bright yellow color. Concentric circles are usually apparent between this nipple and the outside edge. The scaly covering is formed at the edge in concentric layers or additions. The covering of the male is different in shape from that of the female. While that of the female is nearly circular in outline, the armor of the full-grown male scale is nearly always elongated, with the nipple near one end, and the lines of formation are eccentric instead of concentric. (See Fig. 1.)

The color of the shell or covering varies greatly, sometimes being a light grey, sometimes being nearly black. It frequently turns dark if the insects are killed when half grown. If killed when fully grown, the shells often assume a light grey color, and finally drop from the twigs. If we lift this shell or covering with a pin or point of a knife, we will see underneath a small yellow object, oval or circular in outline, which appears like a bit of yellow jelly. This is the insect proper and is shown in the illustration on Plate III, a.

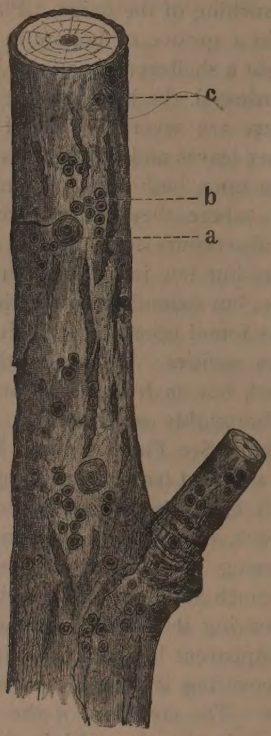


FIG. 1. Appearance of San José scale on peach twig. a. mature females: b. young females: c. immature males. About twice natural size.

FOOD PLANTS.

According to Howard* and Lintner† the scale occurs on the following plants: Apple, pear, quince, peach, plum, cherry, mountain ash, hawthorn, Japanese quince, linden, *Euonymus,* almond, apricot, *Spiræa,* raspberry, rose, cotoneaster, gooseberry, currant, flowering currant, persimmon, acacia, lilac, elm, osage orange, English walnut, pecan, weeping willow and laurel-leaved willow.

* Bulletin No. 3, New Series, Division of Entomology, U. S. Department of Agriculture, Washington, D. C., p. 38.

† Bulletin of the New York State Museum, Vol. 3, No. 13, p. 295.

In addition to the above-mentioned food plants, Rolfs and Quaintance* give chestnut, black walnut, Carolina poplar, Lombardy poplar, cut-leaved birch, flowering cherry, flowering peach, grape, *Catalpa,* and sumac.

In Connecticut, the writer has found it upon cut-leaved white birch, dogwood, Japanese walnut, grape, California privet, and several species of willow. In Hartford the scale has already attacked the wild choke-cherry and shad bushes in sprout-lands. While the insect usually attacks plants belonging to the Rose family, there is reason to believe that it may attack any species adjacent to infested trees. Of the orchard trees, Japanese plum, pear, apple, quince and peach, are most often infested, while the cherry and European plum are less frequently attacked.

The purple-leaved plum is perhaps the most subject to attack of all the ornamental plants. Mountain ash, hawthorn, and *Cydonia* are, however, frequently injured by it.

How the Scale Spreads from Tree to Tree.

The young scales crawl about for a few hours on the bark, and if the trees stand so close that the branches interlace, of course they can readily crawl from one to the other. They are scarcely able to crawl long distances from the trunk of one tree to another over the rough ground, but are often blown about on fallen leaves and may reach a different section of the orchard in that way. In cultivating nurseries, the workmen brush against the young trees, and it is quite possible for some of the young insects to be carried to other trees along the nursery rows.

In one case, an orchard became infested by hitching a horse to one of the trees, after the team had been in an infested orchard three miles distant.† The throwing about of infested fruit may aid in distributing the pest. Also where parings of infested fruit are thrown out into gardens, there is danger that near-by trees may become infested.

As a rule, however, the insect is carried to distant trees either by other insects or upon the feet of birds.

*Coccidæ Americanæ, Decades I and II, No. 15.

† Bulletin No. 3, New Series, Division of Entomology, U. S. Department of Agriculture, Washington, D. C., p. 50.

Effect upon Trees.

The effect on the vitality of the tree is not apparent until the twigs become nearly covered by the insect. Then it may be noticed that the tree seems unthrifty, but the scale is so inconspicuous that frequently the tree loses some of its branches or dies before the cause of the trouble is discovered. The illustration on Plate II shows a peach tree which has been severely injured, and the branches are dead, but the trunk is still alive and making an effort to grow a new top. This form of injury is one often seen, and frequently the owner does not discover the cause until his trees reach this condition. A plum tree killed by the scale is shown on Plate I. The length of time required to kill a tree depends on various factors. In certain seasons the species multiplies much more rapidly than in others, depending undoubtedly upon the weather and the abundance of natural enemies. The writer has known of several localities where ornamental plants were attacked and no measures taken to destroy the scale, yet for two or three years the insect has not spread to any appreciable extent. On the other hand, in certain orchards, it has spread with great rapidity in spite of vigorous combative measures. In Mr. Raub's garden at New London, large peach trees were killed by the scale in four years.

Remedies.

All infested trees which are worthless or of little value should be destroyed, as the owner cannot afford to treat them; he had better obtain new trees.

Spraying.

There have been many different applications used in Connecticut to kill this scale-insect. The most successful, perhaps, is either crude oil, applied just before the leaves are put out in the Spring, or a mixture of kerosene and water (20 to 25 per cent. kerosene), applied at the same time. The crude oil possesses one advantage. A portion of it stays on the bark for several months, so that it would seem impossible for the young scales to become established. Kerosene, on the other hand, evaporates readily and, after a few weeks, can not be detected by odor or by the appearance of the twigs. Experiments conducted by us

during the past season, show that either the crude oil, or 20 per cent. kerosene and water, if thoroughly applied, will kill the insects without causing any serious injury to the trees. An account of these experiments will appear in a forthcoming Bulletin. It is not safe to apply any form of petroleum on a damp, cloudy day. It must be used in pleasant weather, and must be applied in the form of a fine spray.

We have found the "Kerowater" barrel pump, made by the Goulds M'f'g Co., Seneca Falls, N. Y., to give satisfaction in orchard work. For a few small trees in the garden there is probably nothing better than the "Success" bucket pump made by the Deming Co., Salem, Ohio. These pumps are not kept in stock by local dealers, but must be ordered from the manufacturers. The "Vermorel" is the best nozzle we have employed for kerosene spraying, but a cap with small aperture should be used. In infested orchards this spraying is likely to be adopted as the best practical way of holding the pest in check. Fumigating is here too expensive.

According to experiments made in New Jersey, certain grades of crude oil are liable to cause injury to the trees. If the oil has a specific gravity of not less than 43° (Beaumé), there is little danger. It need not be above 45° however. As the term "crude petroleum" is rather vague in meaning, it is necessary to specify, in ordering, what grade of oil is required. In order that Connecticut fruit growers may obtain the proper grade of oil for insecticide purposes, I have arranged with the Standard Oil Company to furnish it. Orders should be sent to the Providence Department of the Company, Mr. P. M. Watt, Manager, 136 South Water St., Providence, R. I. This oil is not kept in stock at the distributing stations, but shipments can be made quickly from New York. The present price is 9½ cents per gallon, including barrel, but of course the price is subject to changes. In ordering, call for "Insecticide Oil."

A solution of whale-oil soap (2 lbs. of soap to 1 gallon of water) sprayed upon the trees is regarded as the best remedy in many localities. It is probably less liable to injure trees than the kerosene or crude oil, and may be applied at any time during the winter. But it is an expensive treatment for large orchards, and from our observations in Connecticut it does not seem to be as effective in destroying the insects as

kerosene or crude oil. It is also difficult to apply in the form of a spray. Whale-oil soap fairly uniform in composition may be obtained from the manufacturers, James Good, 514-518 Hurst St., Philadelphia, Pa., and Leggett & Bro., 301 Pearl St., New York.

The above-mentioned treatment applies only to dormant trees. If the insect is discovered during the Summer when the trees are not dormant, it may be held in check for the season by spraying with 15 per cent. kerosene and water, or whale-oil soap solution (1 lb. to 5 gallons of water), which will kill most of the young scales which are crawling upon the bark.

Fumigating.

In nurseries where the trees are dug up in shipping season, the scales upon them can easily be destroyed by fumigating with hydrocyanic acid gas. A tight box, tent, or room, is required for this purpose, and our leading nurserymen are now provided with some sort of equipment for fumigating their nursery stock. In fact, some of their large orders reach them with the request that the stock be fumigated before being sent out: even when it is not known to be infected. The formula which we have been using in Connecticut requires for each 100 cubic feet of space,

Cyanide of potash (97 per cent.)	25 grams, ⅝ oz. (by weight)
Sulphuric acid (Sp. G. 1.83)	1¼ oz. (liquid measure)
Water	1⅞ oz. (liquid measure)

The enclosed space should be computed with care, and the chemicals measured out accordingly. The house should of course be filled with the trees before preparing the chemicals. A stoneware jar of suitable size makes a good generator. The water should first be put into this jar and the acid poured in slowly with constant stirring. The jar should be set inside, and within easy reach of the door or cover. The cyanide is then dropped into the jar quickly, and the house closed from the outside. The person should leave at once, as the fumes are extremely poisonous and might cause death if one should breathe them. The trees should be left for half an hour, when the house may be opened in order to let the fumes escape. It is not safe for persons to enter for several minutes. While this treatment is not certain to kill every individual scale-insect, it is one of the

surest methods that we know of destroying them. Small orchard trees can be fumigated in this manner, by covering them with a gas-tight tent, beneath which the gas is generated, but for large orchard trees, an expensive outfit is required to handle the tents. There is also some difficulty in computing the space. Chiefly on account of the expense, however, this has not been practiced to any extent in Connecticut. The fumigation of nursery stock must be, from now on, a common practice. The materials may be obtained from any wholesale druggist.

Summary.

(1) The San José Scale appeared and caused much destruction of fruit trees in California twenty years ago. China is probably the country of its origin.

(2) It was first found in the Eastern states in 1893, and now occurs in nearly all the states of the Union, except perhaps, the extreme Northern ones.

(3) The scale was brought into Connecticut on nursery stock ten years ago, but not discovered until 1895. Seventy-eight infested localities had been found up to July 1st, 1901, when the new Insect Pest Law went into effect.

(4) The Station began the work of inspecting nurseries in 1897, at the request of nurserymen. This enabled them to ship stock into other states where inspection laws existed. Fifty inspections were made and thirty-nine certificates granted under this arrangement. Twenty-five other states had enacted inspection laws, before the Connecticut law was passed.

(5) The full grown female scale gives birth to living young, which crawl about for a short time and then settle upon the bark. There are three or four generations each season. They feed by sucking the juices from the tree. Each female may produce from less than one hundred to six hundred young.

(6) The scale is inconspicuous and is seldom noticed until the vitality of the tree is impaired, at which time the bark is usually coated with a roughish grey substance. The reddish discoloration may be found around each individual. Leaves and fruit are also attacked. The female scale is nearly circular in outline, while the male is somewhat elongated. If the scale is lifted, the insect proper may be seen underneath, by the aid of a lens, as a yellow object.

(7) Common fruit trees and plants of the Rose family are usually preferred by the insect, but it is liable to attack almost any variety of tree or plant that may be growing near infested trees.

(8) Though the young scales crawl short distances, they are usually carried from one tree to another by other insects, or upon the feet of birds. They may also be carried upon fallen leaves, fruit, or the clothing of persons, etc.

(9) The vitality of the tree is gradually lessened by the hordes of insects sucking its sap. The pest is seldom noticed until some of the twigs die. Entire trees have been killed in four years in Connecticut by the scale.

(10) Spraying the trees just before leaves appear in the Spring, with crude oil, or with a mechanical mixture of kerosene oil and water, using 20 per cent. kerosene, is the best remedy that we can now recommend for large orchard trees.

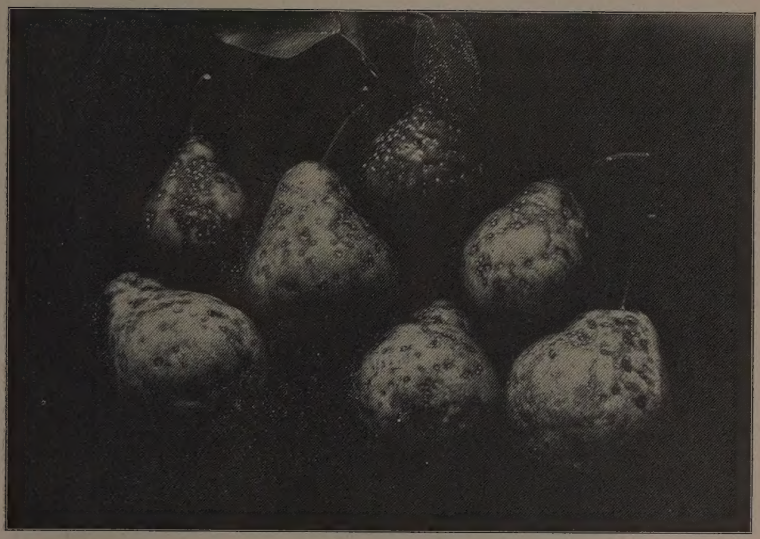
Whale-oil soap and water, in the proportion of 2 lbs. of soap to 1 gallon of water, sprayed upon the dormant trees, is also an effective treatment. Growing trees may be treated with 15 per cent. kerosene and water, or whale-oil soap (1 lb. in 5 gallons of water). For nursery stock, fumigating with hydrocyanic acid gas is the cheapest and most effective treatment.

Plum Tree killed by the San José Scale-Insect.

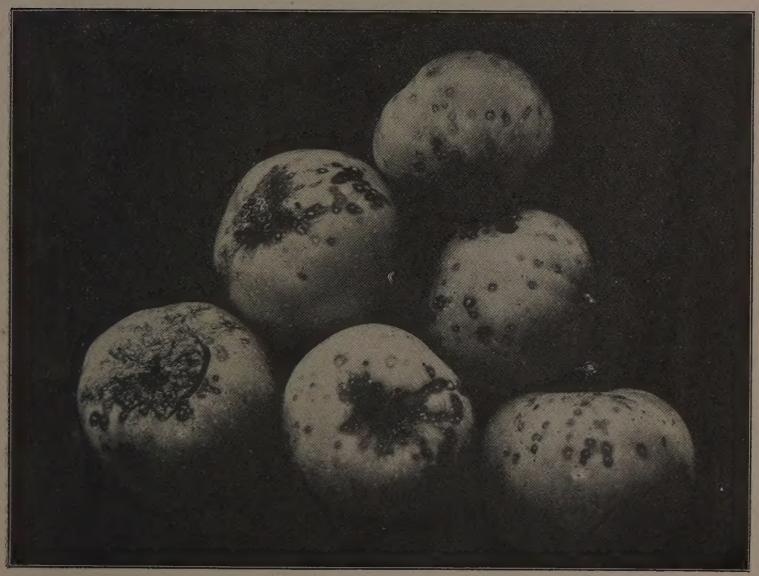
Peach Tree severely injured by the San José Scale-Insect.

(*a*) Infested Peach Twigs. Mature females and young scales clustered in a groove of the twig may be seen at the left. A female with the shell or covering raised is shown at the right. Considerably enlarged.

(*b*) Plum Twigs nearly coated over by San José Scale. Natural size.

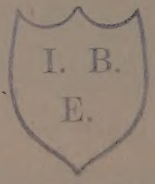


(*a*) Pears badly infested.



(*b*) Infested Apples showing the discoloration around the Insects.

Appearance of Infested Fruit.


I. B.
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(*a*) Plums showing the reddish discoloration caused by the Insects.

(*b*) Leaves, showing the tendency of the Insects to locate near the veins.

Infested Leaves and Fruit of Japanese Plum.

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